

PUERTO RICO AND VIRGIN ISLANDS
PRECIPITATION FREQUENCY PROJECT

Update of *Technical Paper No. 42* and *Technical Paper No. 53*

Fifteenth Progress Report
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Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
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DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk

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Update of *Technical Paper No. 42* and *Technical Paper No. 53*

1. Introduction

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service is updating its precipitation frequency estimates for Puerto Rico and the Virgin Islands. Current precipitation frequency estimates for the area are contained in *Technical Paper No. 42* "Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands" (U.S. Weather Bureau 1961) and *Technical Paper No. 53* "Two- to ten-day rainfall for return periods of 2 to 100 years in Puerto Rico and Virgin Islands" (Miller 1965). The new project includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The project will determine annual precipitation frequencies for durations from 5 minutes to 60 days, for return periods from 2 to 1,000 years. The project will review and process all available rainfall data for the Puerto Rico and Virgin Island project area and use accepted statistical methods. The project results will be published as a Volume of NOAA Atlas 14 on the internet using web pages with the additional ability to download digital files.

The project area covers Puerto Rico and the U.S. Virgin Islands of St. Thomas, St. John and St. Croix. The project area is currently divided into 7 homogeneous climatic regions for analysis (Figure 1).

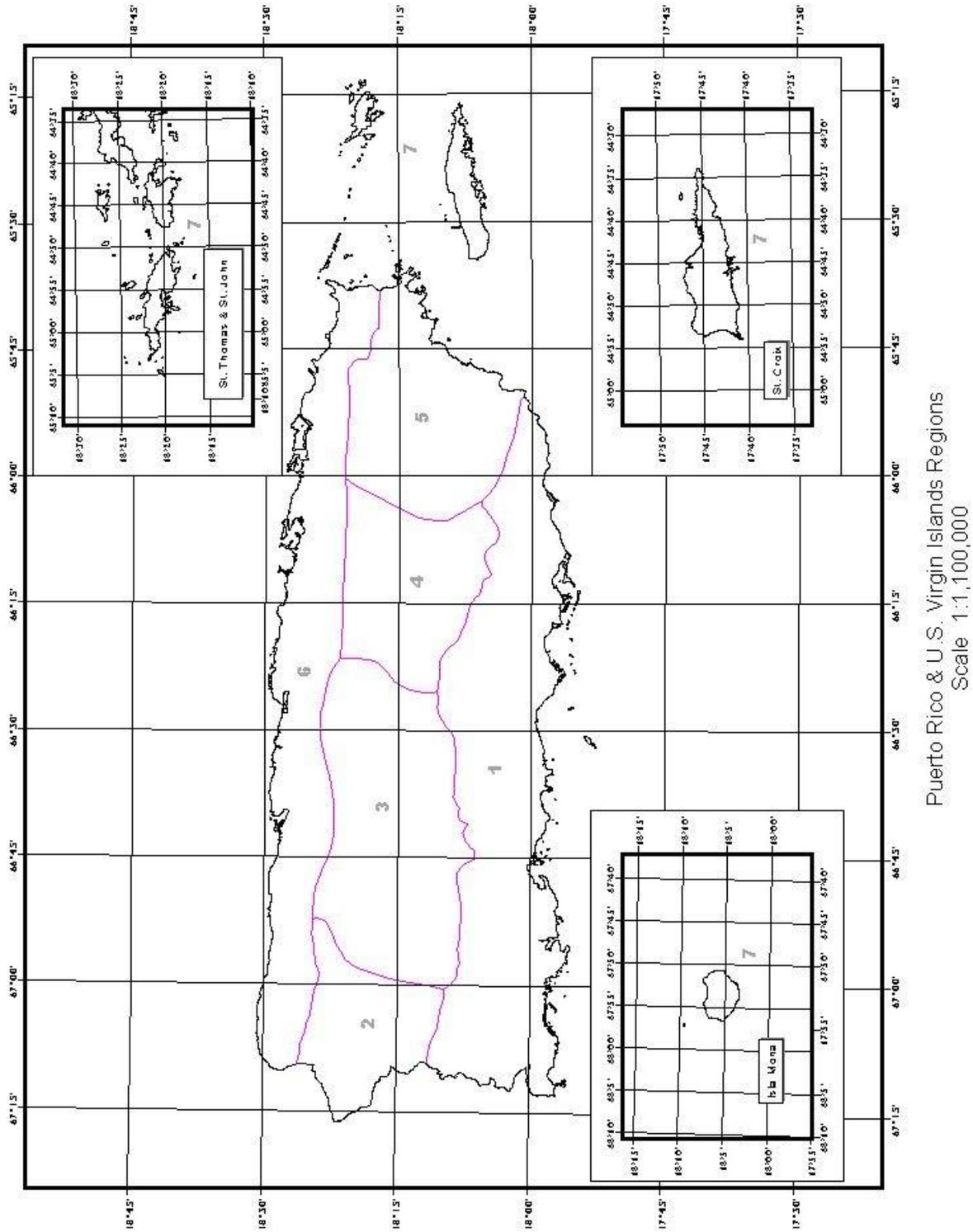


Figure 1. Puerto Rico Precipitation Frequency project area and region boundaries.

2. Highlights

The hourly and daily datasets from the National Climatic Data Center were updated through 12/2002. The U.S. Geological Survey has sent updated data for the 15-minute gages which it maintains. Quality control has begun on the daily and hourly datasets. Erroneous coordinates for 2 stations were found and corrected. Additional information is provided in Section 3.1, Data Quality Control.

Software was written to check for common data errors found in the accumulations of longer durations. Software was written to make hourly-only stations consistent with nearby co-located hourly/daily stations and thereby reduce potential bull's eyes in the hourly results. Additional information is provided in Section 3.2, Software Updates.

Study areas to be used and tested in the areal reduction factor (ARF) development have been selected and all but one have been quality controlled. Three additional study areas were added. Software development to process the data and ultimately generate the ARF curves is complete. Additional information is provided in Section 3.3, Areal Reduction Factors.

3. Progress in this Reporting Period

3.1 Data Quality Control

The hourly and daily datasets from the National Climatic Data Center were updated through 12/2002 during this reporting period. The initial quality control of the daily data is nearly complete. All daily events greater than a threshold of 4 inches were checked. Questionable values were compared to nearby stations, published versions of NCDC Climatological Data and/or original observation forms as posted on NOAA's "Web Search Store Retrieve Display" (WSSRD) website. Incorrect values were replaced with correct values where available or set to missing. The four remaining issues to be resolved regarding the daily data are listed in Table 1. These issues have been sent to the state climatologist for review.

The initial quality control of the hourly data from 10/1998 through 12/2002 is complete. All 1-hour events greater than a threshold of ~1.5 inches were checked. In addition, HDSC will verify the quality of the entire hourly dataset.

The U.S. Geological Survey has sent recent provisional data collected from the 15-minute gages which it maintains. The new data could extend the existing 15-minute data at those sites through 12/2003. These data will also be extensively quality controlled.

Erroneous coordinates for two daily stations were found. Water Isle (67-9222) was listed as 18.3200 decimal degrees North and 64.9500 decimal degrees West in our metadata. It should have been 18.3167 North and 64.9660 West. Anna's Hope (67-0260) was listed as 66.7333 decimal degrees West but should have been 64.7333 West. These have been corrected in our dataset.

Table 1: 1-day precipitation measurements in Puerto Rico to be resolved.

Station	Date (mm/dd/yyyy)	Value (inches)	Remarks
MAYAGUEZ AIRPORT (66-6083)	08/22/1960	30.63	Listed in Climatological Data (CD) publication under the daily total but not included in the monthly total. Nearby stations reported little rainfall. Possibly 3.63?
DORADO 2 WNW (66-3409)	04/29/1953 and 04/30/1953	Consecutive, exact 10.00 totals	These are listed without explanation in CD and are suspicious. Nearby stations reported zero rain on those days.
CANOVANAS (66-1590)	06/11-6/12/1919	14.83	Mentioned in the text of CD as "the greatest in 24 hours" but listed as 3.80 on the 11 th and 11.30 on the 12 th in the table of the same report.
PICO DEL ESTE (66-6992)	09/10-9/11/1996	21.80 accumulated over 2 days	Listed as 21.00 inches on B-91 form with a mention that "the F&P measured only 10.00" in the same period. 21.80 is accumulated over 9/10 to 9/11 in CD record.

3.2 Software Updates

Software was written to check for data errors commonly found in the accumulations of daily values for longer durations. The software flags the following:

1. Recurring daily precipitation amounts above a user-entered threshold in a month
2. Consecutive recurring daily precipitation amounts above a user-entered threshold in a month
3. Months in which all daily amounts are zero or missing except for a daily amount that is above a user-entered threshold on one of the last 3 days

These flagged occurrences can then be checked for data errors that may impact longer duration accumulations.

Software was written to make hourly-only stations consistent with nearby co-located hourly/daily stations and thereby reduce any potential spatial artifacts, specifically bull's eyes, in the mapped hourly precipitation frequency estimates. The software adjusts hourly quantiles according to their co-located daily station and/or according to the overlapping daily regional characteristics. Specifically, hourly stations that are co-located with a daily station are adjusted using ratios of the 24-hour station means and ratios of the daily and hourly regional growth factors. Hourly-only stations are adjusted using an average ratio of the daily and hourly regional growth factor ratios for all co-located stations within the hourly region.

3.3 Areal Reduction Factors

Progress continues in the development of geographically-fixed Areal-Reduction-Factor (ARF) curves for area sizes of 10 to 400 square miles. Development and testing of software from the procedure described in NOAA Technical Report NWS 24 (TR-24) is complete. A preliminary set of ARF curves for the 2-year return period for the Chicago, IL area study site has been generated (see Figure 2). They are consistent with results published in TR-24.

Three additional study areas (southeast Michigan, Albuquerque, and Seattle) have been identified and added to the list of areas used to develop the final set of ARF curves. Quality control on the Hawaiian hourly reporting data (covering the period 1960 through 2002) and additional Puerto Rico hourly reporting data (covering the period 1998 through 2002) has been performed and completed. Only the Seattle dataset remains to be quality controlled. A total of 15 study areas throughout the United States will be used in the study (see Figure 3). The "not used" study areas indicated in Figure 3 were considered but judged inadequate for the study due to poor data, limited or no metadata, or other problems. The set of ARF curves developed for each study area used will be tested for differences to determine if a single set of ARF curves can be used for the entire U.S. as is the case today or whether separate curves for different regions of the country are more appropriate.

Figure 2: Preliminary ARF curves based on test data in the Chicago area.

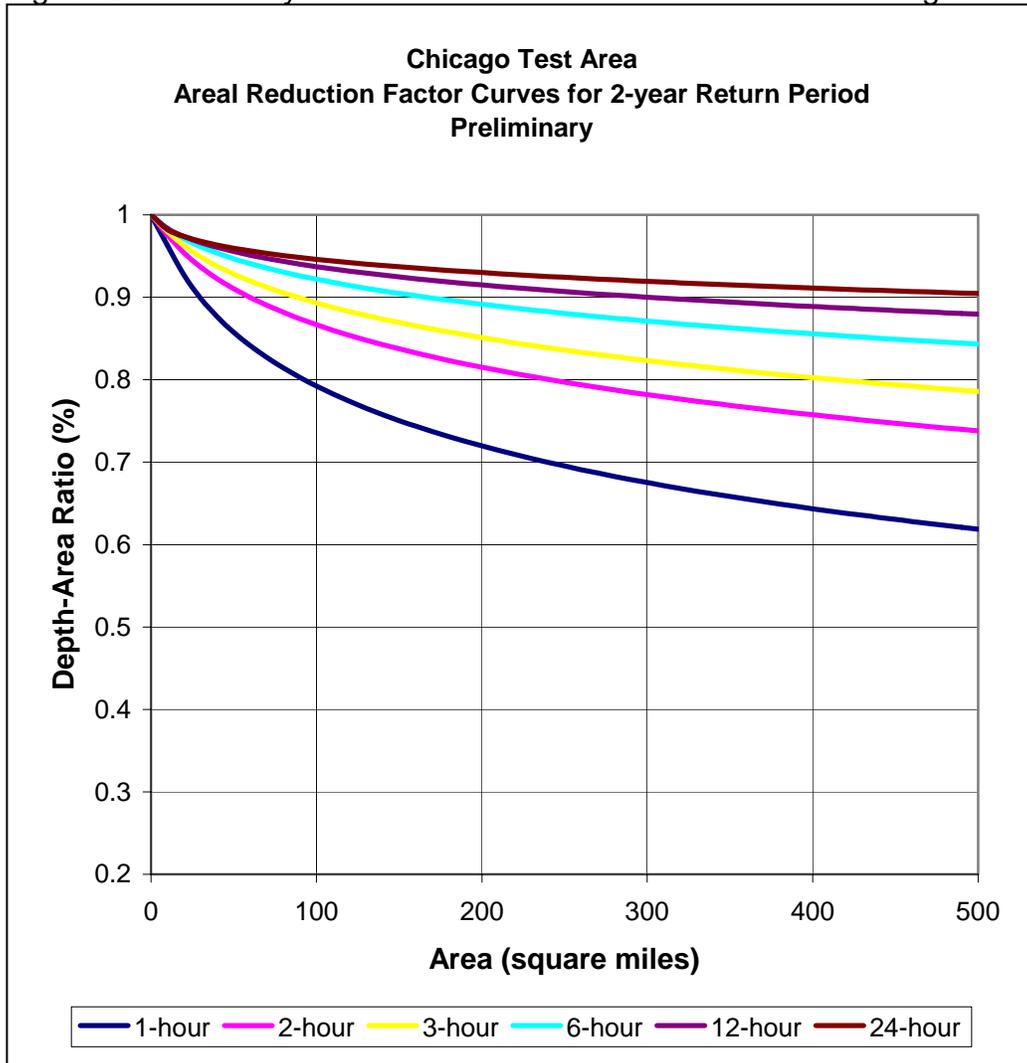
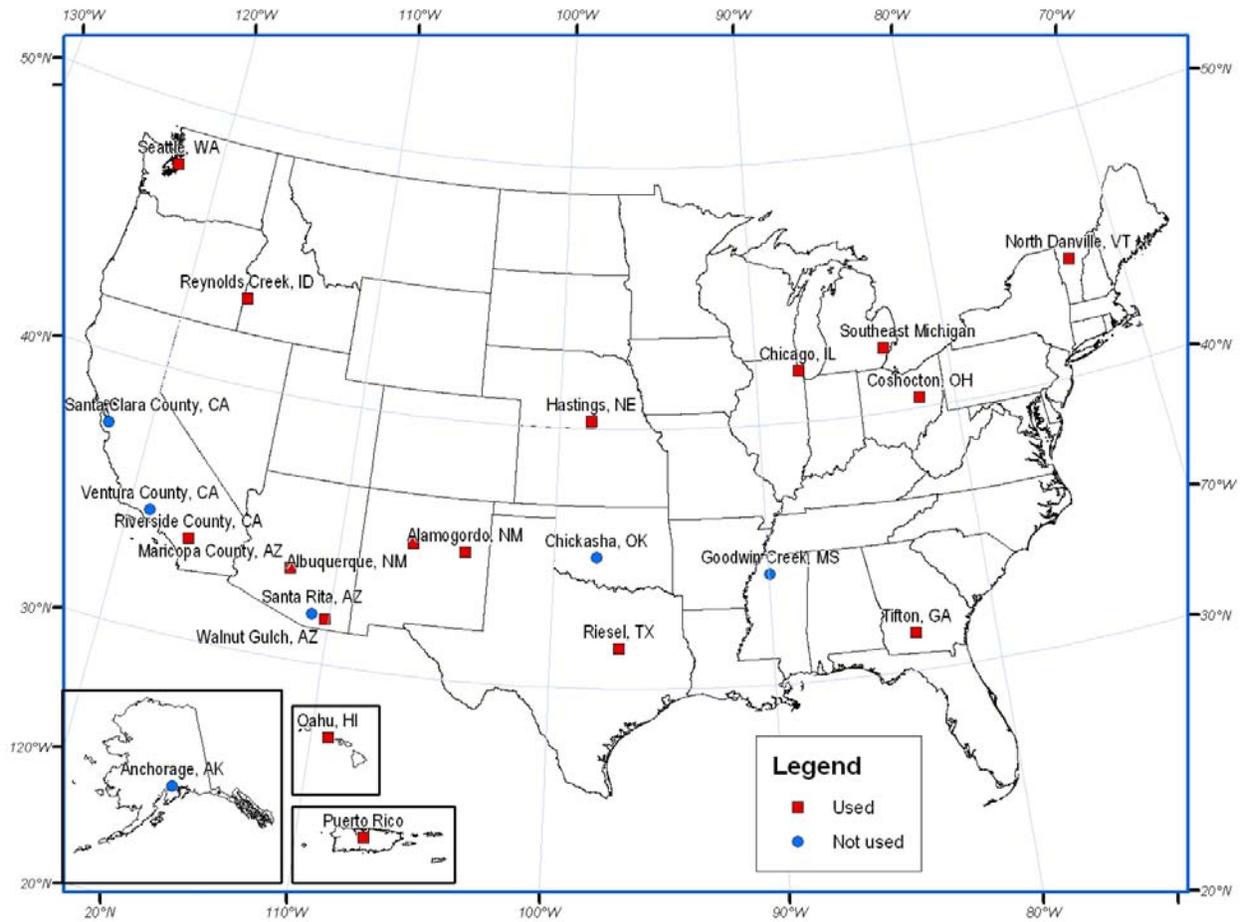


Figure 3: Map of ARF study areas



4. Issues

4.1 Recent and Upcoming Presentations

Past and future presentations by Geoff Bonnin, representing HDSC, include the following:

- “Temporal Distributions of Heavy Rainfall Associated with Updated Precipitation Frequency Estimates” at the Transportation Research Board Conference in Washington DC on January 15, 2004
- “Recent Updates to NOAA/NWS Rainfall Frequency Atlases” at the American Association of Geographers Annual Meeting in Philadelphia, PA on March 18, 2004
- “Recent Updates to NOAA/NWS Rainfall Frequency Atlases” at the Southeast Region meeting of the Association of State Dam Safety Officers in Norfolk, VA on April 19, 2004
- “Statistics of Recent Updates to NOAA/NWS Rainfall Frequency Atlases” at the American Society of Civil Engineers World Water and Environmental Resources Congress on June 28, 2004
- “Recent Updates to NOAA/NWS Rainfall Frequency Atlases” at the California Extreme Precipitation Symposium in Davis, CA on July 1, 2004

5. Projected Schedule and Remaining Tasks

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks to be worked on are also included in this section.

Data Collection and Quality Control [May 2004]
Trend Analysis [July 2004]
Temporal Distributions of Extreme Rainfall [July 2004]
L-Moment Analysis/Frequency Distribution [August 2004]
Peer Review of Spatially Interpolated Point Estimates [August 2004]
Spatial Interpolation [September 2004]
Precipitation Frequency Maps [November 2004]
Web Publication [September 2004]
Spatial Relations (Areal Reduction Factors) [June 2004]

5.1 Data Collection and Quality Control

During the next quarter, quality control of the updated daily, hourly and 15-minute datasets will occur. All durations will be extracted upon the completion of the initial quality control process.

5.2 L-Moment Analysis/Frequency Distribution

A comprehensive L-moment statistical analysis will be done on all durations and regions will be reassessed. The tasks involved with the precipitation frequency analysis should be completed by the end of the next quarter.

5.3 Trend Analysis and Temporal Distributions

Once the data have been quality controlled, an analysis for trends in the annual maximum series data and an analysis of the hourly temporal distributions of heavy rainfall can begin.

5.4 Areal Reduction Factors (ARF)

Computations for the ARF curves will be completed in the next quarter for 15 areas. The resulting curves will be tested for differences to determine if a single set of ARF curves is applicable to the entire U.S. or whether curves vary by region.

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